New taxa of earwigs (Dermaptera: Spongiphoridae: Spongiphorinae) in lower Miocene amber from Simojovel, Chiapas, Mexico

Nuevas taxas de tijerillas (Dermaptera: Spongiphoridae: Spongiphorinae) en ámbar del Mioceno temprano de Simojovel, Chiapas, México

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ABSTRACT

New Dermaptera taxa (one new genus and four new species) are reported from amber pieces proceeding from Mina Los Pocitos near Simojovel de Allende, Chiapas. The amber pieces were collected in the lower Miocene Mazantic Shale, including well-preserved earwigs, with only one antecedent for this insect group in the Mexican amber. The presence of this kind of insects supports the paleoenvironmental interpretation for the Mazantic Shale amber as of a humid forest.

Keywords: Hexapoda, Dermaptera, new genus and species, lower Miocene, Mazantic Shale, Chiapas.

RESUMEN

Nuevos dermápteros (un género nuevo y cuatro especies nuevas) son reportados de piezas de ámbar procedentes de la Mina Los Pocitos, cerca de near Simojovel de Allende, Chiapas. Las piezas de ámbar, colectadas en la Lutita Mazantic del Mioceno inferior, incluyen ejemplares bien preservados de tijerillas, con solo un antecedente de este grupo para el ámbar mexicano. La presencia de este tipo de insectos apoya la interpretación paleoambiental de un bosque húmedo para el ámbar de la Lutita Mazantic.

Palabras clave: Hexapoda, Dermaptera, nuevo género y especies, Mioceno inferior, Lutita Mazantic, Chiapas.

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1. Introduction

Dermaptera (earwigs or "*tijerillas, tijeretas*" in Spanish) is a small group representative nearly 2000 species, which are mainly distributed throughout the southern continents, greater diversity in tropical regions, especially in South-East Asia and in the Neotropics (Popham, 2000). Earwigs are medium-sized hemimetabolous insects, easily recognized by the presence of front wings modified like short tegmina, well developed hindwings with several lines of folding and the abdomen ended in forceps-like cerci (almost all species) (Núñez-Bazán *et al.*, 2022). The order currently has 2494 species, 367 genera, 27 families in 12 superfamilies (Hopkins *et al.*, 2021). Fossil earwigs have not been reported from Chiapas, with the exception of *Haplodiplatys* crightoni Ross & Engel, 2013, found in a piece of amber from a mine near Simojovel (Solórzano-Kraemer, 2010; Ross and Engel, 2013). Here we report results from studying of four pieces of amber with earwigs as inclusions.

The fossil record of earwigs extends to the Mesozoic (Grimaldi and Engel, 2005; Tihelka, 2019), in particular the Triassic (Kelly *et al.*,2017), the Jurassic (Vishniakova, 1980; Zhang, 1994, 2002; Ross, 2010; Zhao *et al.*,2010; Ren *et al.*,2019), the Cretaceous (Haas, 2007; Engel *et al.*, 2011; Engel, 2009, 2011; Engel and Grimaldi, 2004, 2014; Engel and Perrichot, 2014; Engel *et al.*,2015; Mao *et al.*,2020), the Eocene (Burr, 1911; Nel *et al.*,2003), the Oligocene (Nel *et al.*,1994) and the amber of the Miocene of Mexico and the Dominican Republic (Ross and Engel, 2013; Ross *et al.*,2016; Engel, 2019).

2. Study area, stratigraphy and paleoenvironment

Famous worldwide for its contents of abundant biological inclusions, the lower Miocene amber from Chiapas, Mexico includes mostly terrestrial

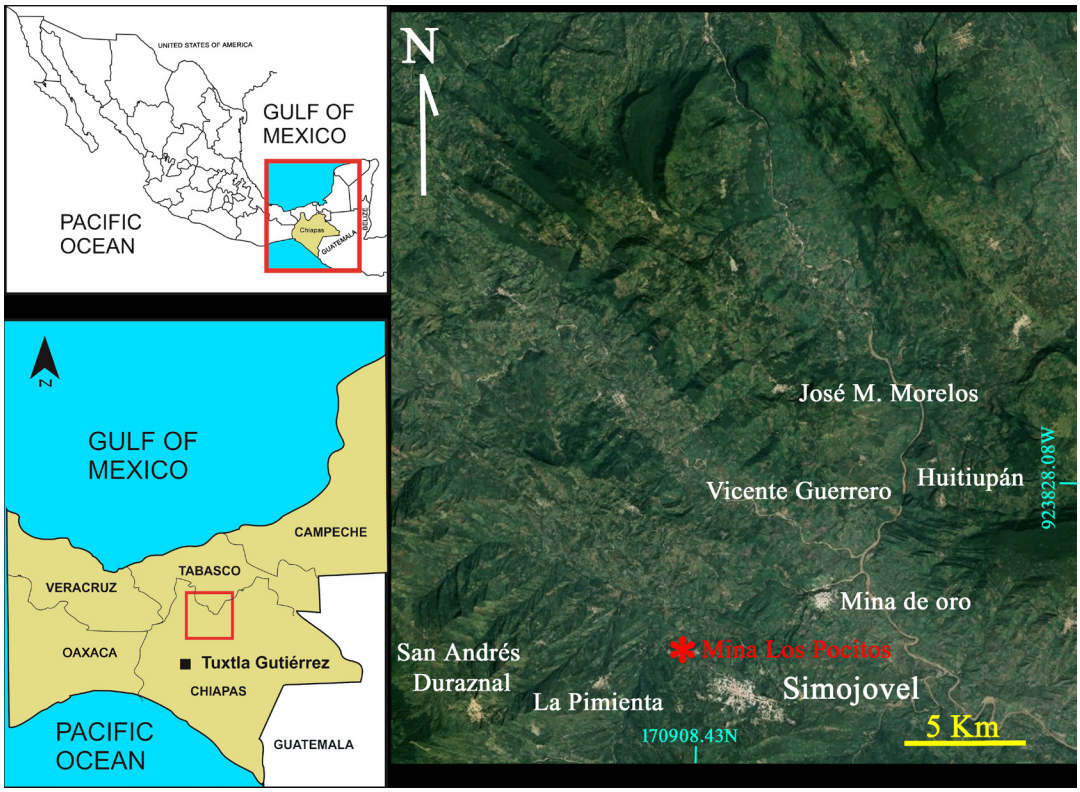

Figure 1 Location map of Los Pocitos mine, approximately 2 km NE of Simojovel Chiapas.

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insects, arachnids, plants and fungi (Solórzano-Kraemer, 2007). Aquatic representatives of algae, ferns, crustaceans, and insects are also present as aquatic representatives, found in lesser amount, but they are very important for deciphering the diverse paleoenvironments where resins, secreted by several kinds of plants, served as traps for living beings and corpses (Serrano-Sánchez *et al.*, 2016). Near the town of Simojovel, located in the Sierra Madre de Chiapas (Figure 1), several amber mines have been exploited by locals during the last decades. The amber can be found in three lithostratigraphic units, known as (from oldest to youngest): the upper portion of La Quinta Formation, the Mazantic Shale and the Balumtun Formation (Figure 2). A precise age based on isotopic and biostratigraphic data indicates that the amber deposit begun 22.8 Ma ago (Vega *et al.*, 2009; Perrilliat *et al.*, 2010; Solórzano-Kraemer, 2010), in estuarine environments, nearby the ancient coast of the Gulf of Mexico (Serrano-Sánchez *et al.*, 2016). The oldest amber, characterized by the stratification of layers of amber, separated by thin layers of sand, contains a diverse estuarine microcrustacean assemblage (Serrano-Sánchez *et al.*, 2016).

The overlying Mazantic Shale contains amber pieces with no aquatic (or very rare) organisms, and is clearer when compared with amber pieces from the basal amber of Campo La Granja mines (Finca Carmitto Member). Plant remains, fungi, and abundant terrestrial insects characterize the inclusions of the Mazantic Shale amber, which deposited in a humid forest (Solórzano-Kraemer, 2010). The insects here described were found in amber pieces from the Mazantic Shale, at Los

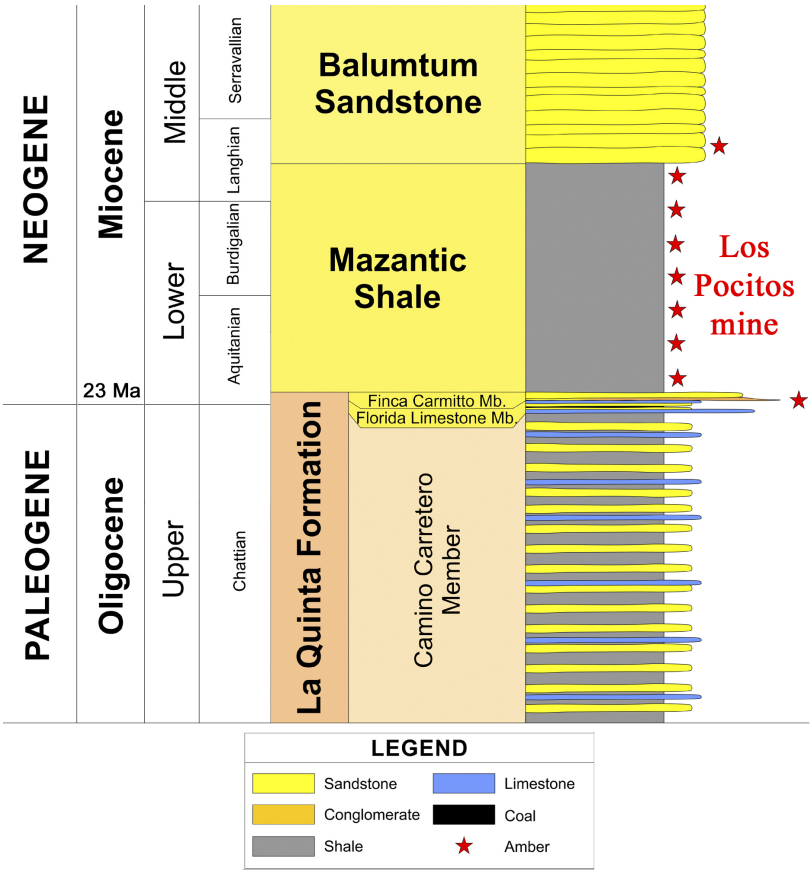

Figure 2 Stratigraphic section at the Simojovel area, indicating position of Los Pocitos mine.

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Pocitos mine, near Simojovel. Solórzano-Kraemer (2007) reported a wide diversity of insects found mostly in pieces from the Mazantic Shale.

3. Materials and Methods

Four pieces of amber from Simojovel de Allende, Chiapas, were examined under a stereoscope at different magnifications, obtaining digital images. The general classification follows Engel and Haas (2007).

The studied pieces are deposited at the Museo de Paleontología "Eliseo Palacios Aguilera", Secretaria de Medio Ambiente e Historia Natural, Estado de Chiapas, Tuxtla Gutiérrez, Chiapas, Mexico, under acronym IHNFG.

4. Systematic paleontology

Order Dermaptera de Geer, 1773
Infraorder Epidermaptera Engel, 2003
[=Forficulina *sensu* Engel and Haas, 2007: 7]
Parvorder Eteodermaptera Engel, 2003
Nanorder Eudermaptera Verhoeff, 1902 Family
Spongiphoridae Verhoeff, 1902 Subfamily
Spongiphorinae Verhoeff, 1902
[=Homotaginae Srivastava, 1985 and Irdicinae
Srivastava, 1985, sensu Engel and Haas, 2007: 5]
Genus Marava Burr, 1911
Marava Burr, 1911: 60 [gen. n.].
Larex Burr, 1911: 60 [gen. n.]. [*sin. jun. sensu*
Brindle, 1971: 551].
Prolabia Burr, 1911: 60 [gen. n.]. [*sin. jun. sensu*
Brindle, 1971: 551].

Type species: *Labia grandis* Dubrony, 1879 [=M. *arachidis*]; by Burr, 1911: 60.

Marava antiqua Estrada-Álvarez and Núñez-Bazán new species (Figures 3a, 3b; 4a-4f; 11a)

Type material. Complete male adult, separate abdomen (Holotype IHNFG-6059).

Type locality and horizon. Simojovel de Allende, Chiapas. Mazantic Shale, lower Miocene (23 Ma).

Diagnosis. Differs from Recent species by the combination of the following characters:
1) Pronotum sub-quadrate, as wide as the head (Figures 3a, 4b); *2)* small eyes, smaller than the gena (Figure 4b); *3)* Antenna with the base of the antennomers very narrow, third antennomer almost as wide as long (Figures 3a, 4a); *4)* Thin tarsomeres and not so abundant setation, second tarsomere simple (Figures 4d); *5)* medially emarginated male pygidium (Figure 4f); *6)* Male forceps basally with subtriangular basal keel (Figure 4f).

Etymology. From the Latin "*antiqua*", ancient.

Description. Overall length 4.9 mm, 0.9 mm maximum width. Glabrous appearance, with sparse setae. Tegmina fully developed, and inconspicuous wings (Figure 3a). *Coloration,* predominantly brown, pronotum, tegmina and legs lighter (Figures 3a and 3b). *Head* (about 0.6 mm

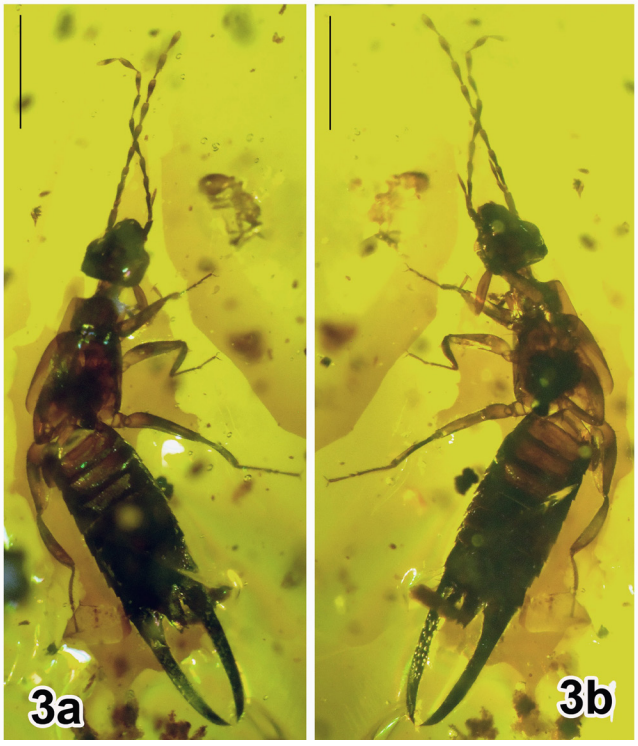

Figure 3 ***Marava antiqua*** **Estrada-Álvarez and Núñez-Bazán new species. Holotype male (IHNFG-6059).** ***(a)*** **Dorsal habitus,** ***(b)*** **Ventral habitus. Scale bar = 1 mm.**

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long, 0.6 mm wide), prognathous, posterior border straight, without occipital carina, Mouthparts unmodified; small eyes (about 0.1 mm) distance between eyes 0.4mm, distance between antennal insertions 0.4 mm; antennae long, total length (about 2.3 mm long), 11(right)-12(left) antennal segments first segment short, second segment subequal to the length of the remaining, third segment short, almost as wide as long, with narrow base, narrower apically, apex of each light segment (Figure 4b). *Pronotum* (about 0.7 mm long, 0.6 mm wide) sub-quadrate, narrower than head, anterior and lateral margins straight, posterior margin procurved (Figure 4c). *Tegmina* (*Forewing*) (about 0.9 mm long, 0.4 mm wide) glabrous (Figure 4e). *Hind wing* not visible, possibly absent (Figures 3a, 4e). *Abdomen* relatively slender (about 1.5 mm long, 0.8 mm wide), simple tergites and sternites (Figure 3a). *Forceps* (1.5 mm long) symmetric, with inner edge in the first third with a keel and, the remaining two thirds conical, the apex is slightly recurved. (Figure 4f). *Pygidium* (about 0.5 mm long, 0.4 mm wide in the base), first half wide, with converging edges, second half with parallel lateral edges, apex emarginated, forming two points (Figure 4f). *Legs: I* Femur (about 0.7 mm long); tibia (about 0.45 mm long); tarsus (0.6 mm long [0.3+0.1+0.2]), second tarsomere simple. *II* Femur (about 0.7 mm long); tibia (about 0.4 mm long); tarsus (0.5 mm long [0.2+0.1+0.2]); *III* Femur (about 0.7 mm long); tibia (about 0.4 mm long); tarsus (0.75 mm long [0.4+0.1+0.25]); arolium absent; tarsal claws simple, long and symmetrical in the three legs (Figure 4d).

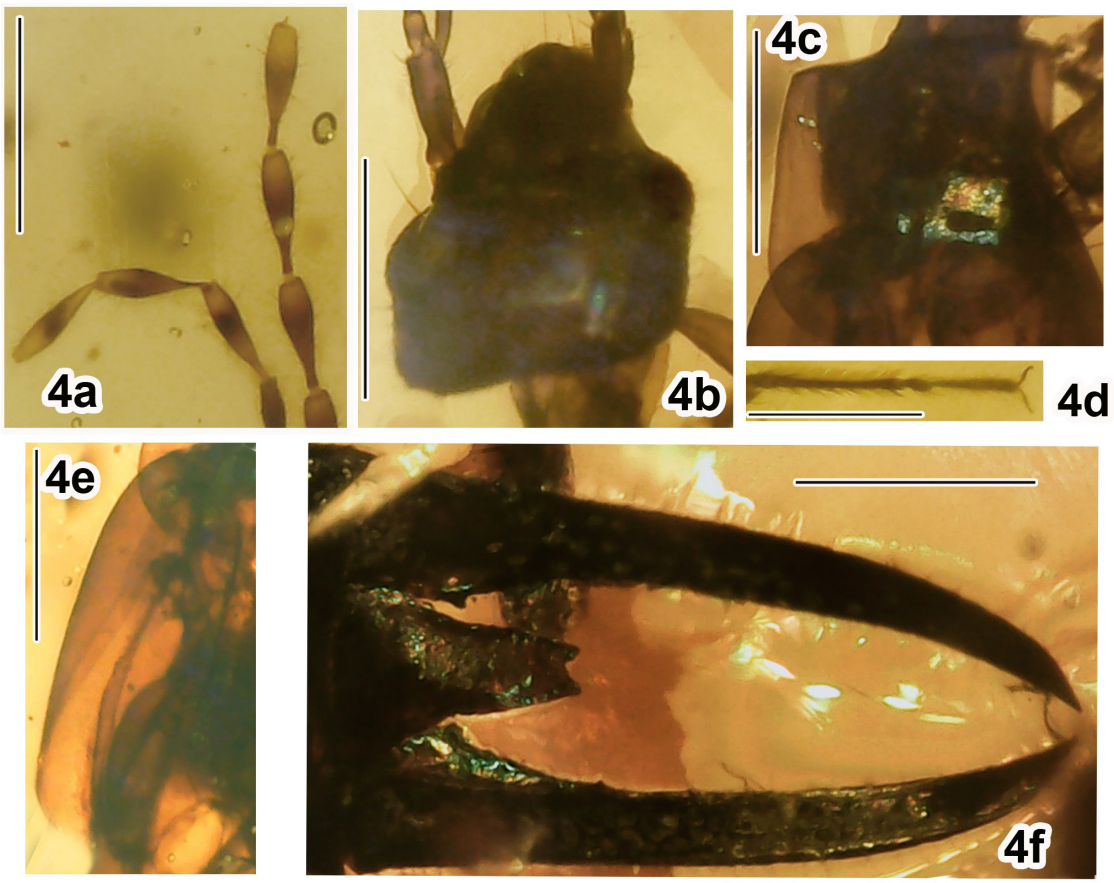

Figure 4 ***Marava antiqua*** **Estrada-Álvarez and Núñez-Bazán new species. Holotype male (IHNFG-6059).** ***(a)*** **Detail of last antennal segments;** ***(b)*** **Head;** ***(c)*** **Pronotum;** ***(d)*** **Hind leg;** ***(e)*** **Tegmina;** ***(f)*** **Forceps and pygidium. Scale bar = 0.5 mm.**

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Marava brevicauda Estrada-Álvarez and Núñez-Bazán new species (Figures 5a, 5b; 6a-6c; 11b)

Type material. Complete male adult (Holotype IHNFG-6060).

Type locality and horizon. Simojovel de Allende. Mazantic Shale, lower Miocene (23 Ma).

Diagnosis. Similar to Marava championi (De Bormans, 1893) in the form of the pygidium with the divergent lateral edges; differs from this species by the short forceps, with very curved apex and pygidium fish-tail shaped (Figure 6c) and absence of numerous small tubercles along posterior margin of last tergite and distal half of 10th antennomers and remaining distal antennomers lighter.

Etymology. From the Latin *brevis* = short and *cauda* = tail, in relation to the short forceps.

Description. 4.3 mm overall length, 0.9 mm maximum width. Glabrous appearance, with sparse setae. Tegmina and wings fully developed (Figure 5a). *Coloration* predominantly brown, abdomen darker (Figures 5a, 5b). *Head* (about 0.6 mm long, 0.7 mm wide), prognathous, posterior border recurved, without occipital carina, mouthparts unmodified; medium eyes (about 0.15 mm) distance between eyes 0.5 mm, distance between antennal insertions 0.4 mm; antennae long, sub-moliniform, total length (about 2.2 mm long), 12(right)-11(left) antennal segments first segment short, second wide segment, third segment short, almost as wide as long, narrower apically, apex of each light segment and last segments lighter (Figure 6a). *Pronotum* (about 0.6 mm long, 0.65 mm wide) sub-quadrate, narrower than head, anterior and lateral margins straight, posterior margin procurved (Figure 6b). *Tegmina* (*Forewing*) (about 1mm long, 0.5 mm wide) glabrous, without considerable deformation, straight posterior edge (Figure 5a). *Hind wing* visible part about 0.7 mm long, covering up to the third tergite (Figure 5a). *Abdomen* relatively slender (about 1.5 mm long, 0.9 mm wide), simples tergites and sternites (Figure 5a). *Forceps* (0.7 mm long) symmetric, with inner edge with serrated ridge covering 60%, a tooth in the first quarter, highly curved apex at 90° angle (Figure 6c). *Pygidium* (about 0.2 mm long, 0.2 mm wide in the base), lateral borders diverging, trailing border slightly curved (Figure 6c). *Legs: I* Femur (about 0.6 mm long); tibia (about 0.45 mm long); tarsus (0.6 mm long [0.3+0.1+0.2]), second tarsomere simple. *II* Femur (about 0.5 mm long); tibia (about 0.35 mm long); tarsus (0.5 mm long [0.2+0.1+0.2]); *III* Femur (about 1 mm long); tibia (about 0.7 mm long); tarsus (0.75 mm long [0.4+0.1+0.2]); arolium absent; tarsal claws simple, long and symmetrical in the three legs.

Ikelus Estrada-Álvarez and Núñez-Bazán new genus

Type species: *Ikelus nuxibus* Estrada-Álvarez and Núñez-Bazán new species.

Figure 5 ***Marava brevicauda*** **Estrada-Álvarez and Núñez-Bazán new species. Holotype male (IHNFG-6060).** ***(a)*** **Dorsal habitus,** ***(b)*** **Ventral habitus. Scale bar = 1 mm.**

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Diagnosis. This genus is recognized by the very short antennae and by the very thickened last antennal segment (Figure 7a; 8a; 11c) and tegminae with diagonal posterior border (Figure 11c).

Etymology. Using the Mayan word *"Ik'el"*, in Latinized form, neutral, meaning "*insect, bug*".

Description genus. See description *Ikelus nuxibus* Estrada-Álvarez and Núñez-Bazán new species.

The taxonomic placement of the genus. The small size and the configuration of the tarsi and antennae place it within the subfamily Spongiphorinae Verhoeff, 1902; the distal antennal segments strongly narrowed at base, place this genus very close to *Marava* Burr.

Ikelus nuxibus Estrada-Álvarez and Núñez-Bazán new species (Figures7a, 7b; 8a-8c; 11c)

Type material. Complete male adult (Holotype IHNFG-6061).

Type locality and horizon. Simojovel de Allende, Chiapas. Mazantic Shale, lower Miocene (23 Ma).

Etymology. From the Mayan *nuxib*, "*old, older*".

Description. 5.8 mm overall length, 1 mm maximum width. Glabrous appearance, with sparse setae. Tegmina and wings fully developed (Figure 7a, 7b). *Coloration* predominantly dark brown (Figure 7a, 7b). *Head* (about 0.6 mm long, 0.7 mm wide), prognathous, the rest not visible; short antennae with the last antennal segment thickened (Figure 8a). *Pronotum* sub- quadrate, narrower than head, anterior and lateral margins straight, posterior margin procurved. *Tegmina* (*Forewing*) (about 1.15 mm long, 0.5 mm wide) glabrous, without considerable deformation and diagonal back edge (Figure 7a). *Hind wing* visible part about 0.8 mm long (Figure 7a). *Abdomen* relatively slender (about 1.8 mm long), tergites and sternites simple (Figure 7a). *Forceps* (1.1mm long) symmetric, with crenulate inner edge (Figure 8b; 11c). *Pygidium* (about 0.2 mm long, 0.2 mm wide in the base), lateral borders diverging, trailing border slightly curved (Figure 8c). *Legs:* Arolium absent; tarsal claws simple, long and symmetrical in the three legs.

Genus *Vostox* Burr, 1911

Vostox Burr, 1911: 59 [gen. n.].

Type species: *Psalidophora brunneipennis* Audinet-Serville, 1839 [*Vostox brunneipennis*]: by original designation Burr, 1911: 59.

Vostox engeli Estrada-Álvarez and Núñez-Bazán new species (Figures 9a, 9b; 10a-10b; 11d)

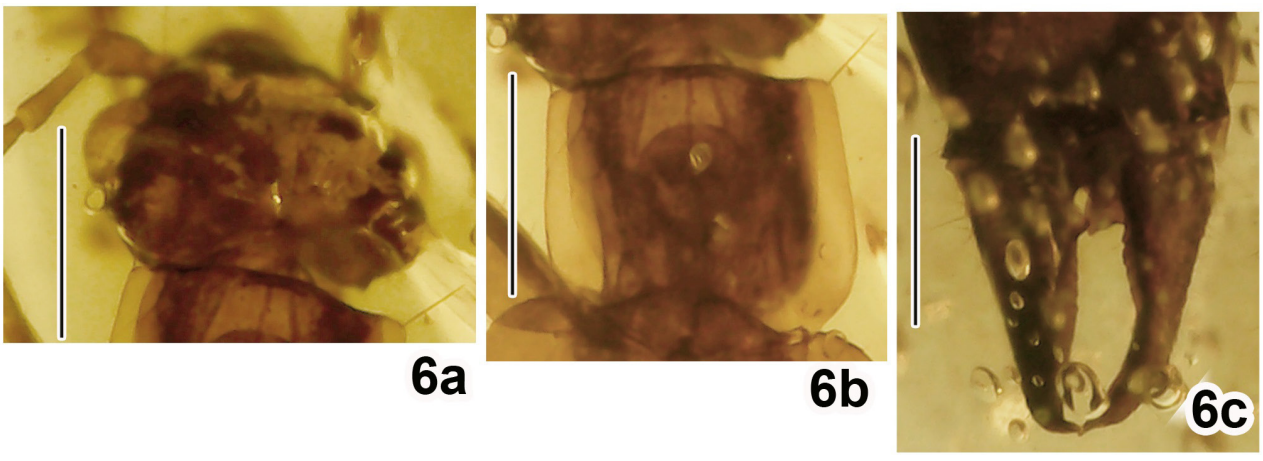

Figure 6 ***Marava brevicauda*** **Estrada-Álvarez and Núñez-Bazán new species. Holotype male (IHNFG-6060).** ***(a)*** **Detail of head;** ***(b)*** **Pronotum;** ***(c)*** **Forceps and pygidium. Scale bar = 0.5mm.**

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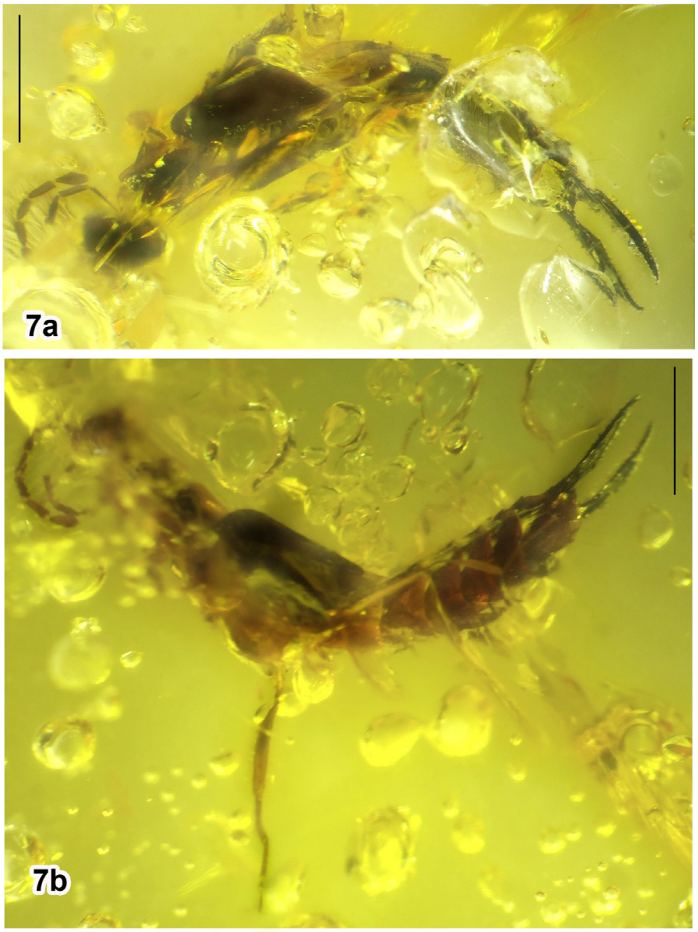

Figure 7 ***Ikelus nuxibus*** **Estrada-Álvarez and Nuñez-Bazán new species. Holotype male (IHNFG-6061).** ***(a)*** **Dorsolateral habitus,** ***(b)*** **Lateral habitus. Scale bar = 1 mm.**

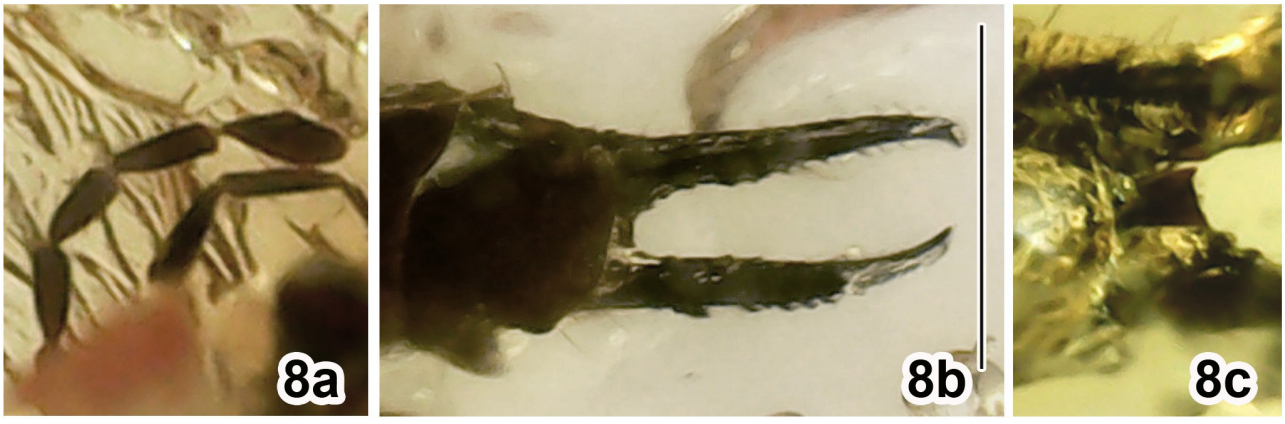

Figure 8 ***Ikelus nuxibus*** **Estrada-Álvarez and Nuñez-Bazán new species. Holotype male (IHNFG-6061).** ***(a)*** **Detail of Head;** ***(b)*** **Forceps;** ***(c)*** **Pygidium. Scale bar = 0.5mm.**

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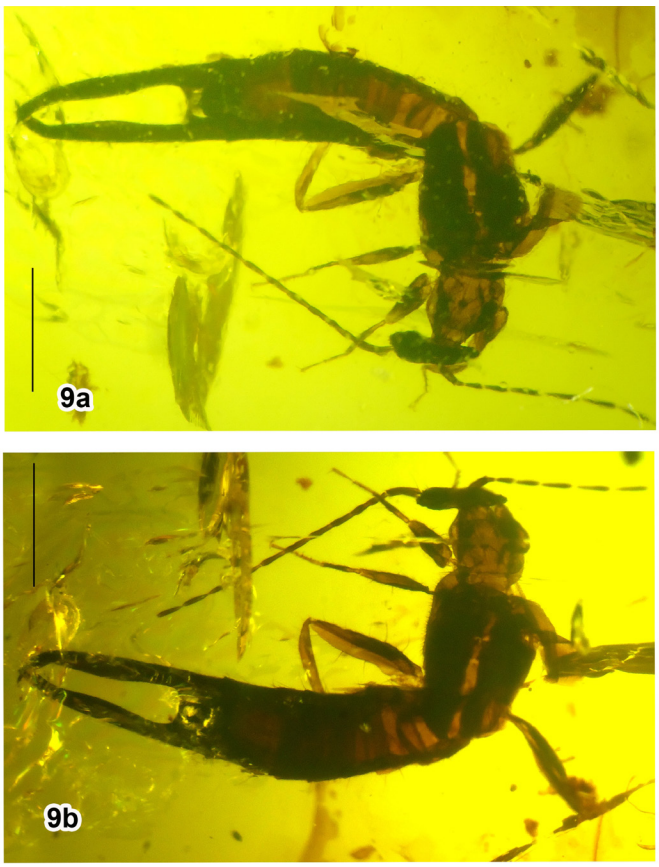

Figure 9 ***Vostox engeli*** **Estrada-Álvarez and Núñez-Bazán new genus and species. Holotype male (IHNFG-6062). (a) Dorsal habitus, (b) Ventral habitus. Scale bar = 1 mm.**

Type material: Complete male adult, enclosed in a piece of amber (Holotype IHNFG-6062).

Type locality and horizon. Simojovel de Allende, Chiapas. Mazantic Shale, lower Miocene (23 Ma).

Diagnosis. Similar to *Vostox brunneipennis* (Audinet-Serville) in general configuration and coloration (differs from this in the presence of a truncated process near the pygidium).

Forceps similar to *V. asemus* (Hebard) and *V. recurrens* (Burr) (differs from these in pygidium morphology) (see key in Brindle 1971).

Etymology. In honor to Dr. Michael S. Engel, for his extensive contributions.

Description. 5.5 mm overall length, 1mm maximum width. Glabrous appearance, with sparse setae. Tegmina and wings fully developed (Figure 9a). *Coloration* predominantly brown, tegminae darker (Figure 9a, 9b). *Head* (about 0.7 mm wide), prognathous, posterior border recurved; antennae long, total length (about 2.5 mm long), 13 antennal segments first segment short, second wide segment, third segment short, apical segments more elongate (Figure 9a). *Pronotum* (about 0.6 mm long, 0.7 mm wide) anterior margin narrow, lateral borders recurved, posterior border sub-straight (Figure 9a). Tegmina (Forewing) (about 1.2 mm long, 0.45 mm wide) glabrous, without considerable deformation, recurved posterior edge (Figure 9a). Hind wing partially deployed about 1.5 mm long. Abdomen relatively slender (about 2.3 mm long, 0.8 mm wide, simples tergites and sternites (Figure 9a). Forceps (1.7 mm long) symmetric, with inner edge with a middle ridge (Figure 10a). Pygidium (about 0.2 mm long, 0.3 mm wide in the base), short median projection, with rounded apex (Figure 10b). *Legs: I* Femur (about 0.5 mm long); tibia (about 0.4 mm long); tarsus (0.5 mm long [0.2+0.1+0.2]), second tarsomere simple. *II* Femur (about 0.7 mm long); tibia (about 0.3 mm long); tarsus (0.6 mm long [0.2+0.1+0.3]); *III* Femur (about 1 mm long); tibia (about 0.8 mm long); tarsus missing; arolium absent; tarsal claws simple, short and symmetrical in the three legs.

5. Conclusions

The new taxa of Dermaptera here reported are an important addition to the diverse insect fauna included in the lower Miocene Mexican amber from Chiapas, which surely is a source for new findings of plants, fungi, and arthropods to be reported in the coming years. Recent relative representants of the family inhabit humid forests, living associated with trunks and barks, being a habitat previously inferred for other insects from the Mazantic Shale amber.

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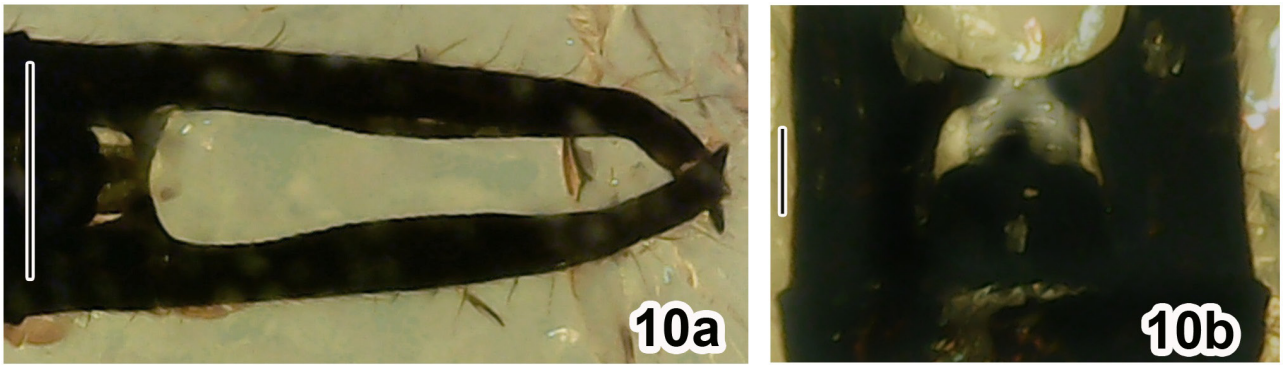

Figure 10 *Vostox engeli* Estrada-Álvarez and Núñez-Bazán new genus and species. Holotype male (IHNFG-6062). *(a)* Forceps and pygidium; *(b)* Detail of Pygidium. Scale bar = 0.5 mm.

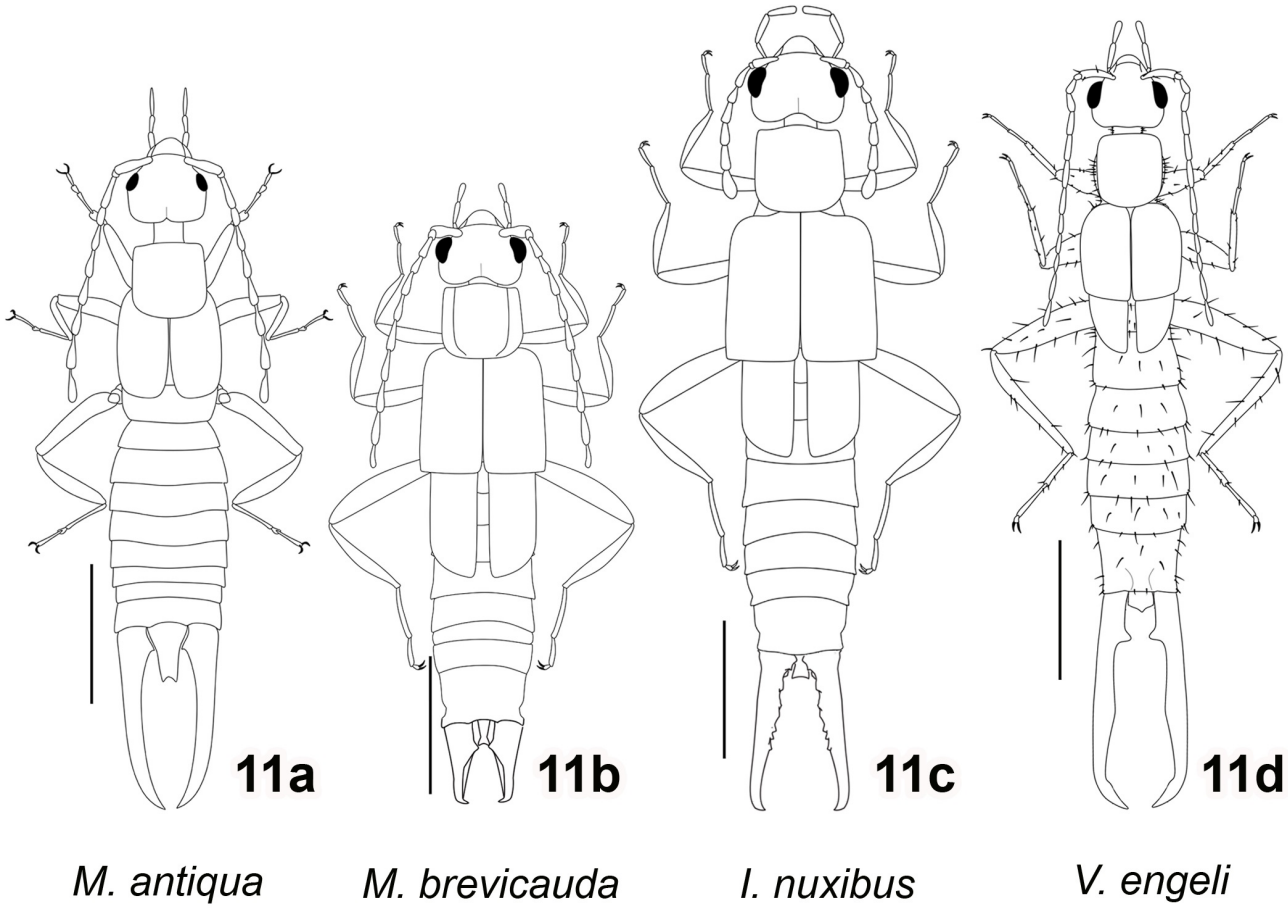

Figure 11 Reconstruction of the species: *(a) Marava antiqua* Estrada-Álvarez and Nuñez-Bazán new species. *(b) Marava brevicauda* Estrada-Álvarez and Núñez-Bazán new species. *(c) Ikelus nuxibus* Estrada-Álvarez and Núñez-Bazán new genus and species. *(d) Vostox engeli* Estrada-Álvarez and Núñez-Bazán new species. Scale bar = 1mm.

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Contributions of authors

Julio C. Estrada-Álvarez – Description of the taxa, photos and drafting. Reinier Núñez Bazán – Reconstruction of species and review of English version. Jorge A. Mata – Drafting and photo assistance.Francisco J. Vega – Geological frame, antecedents, location and stratigraphic figures.

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Conflicts of interest

We declare no conflict of interest.

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